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Subject Handling of Wastes From 205 Building (Up to May 1, 1944)

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HANDLING OF WASTES FROM 205 BUILDING
(Up to May 1, 1944)

Introduction

The process wastes from the separations plant (205 Building) contain the radioactive fission products of the pile chain reaction, the uranium metal salts and all of the process chemicals. All of the waste solutions are treated in Cell 5 with sodium carbonate to neutralize the acidity, raising the pH to about 8. Because of the possible value of the uranium containing waste for future recovery of the uranium, this is not combined with other materials, but is stored separately after neutralization. The other wastes--hereafter called chemical wastes--consist of the waste solution from the aluminum coating removal, the solution of the two bismuth phosphate by-product precipitates, the waste supernatants from both the bismuth phosphate and the lanthanum fluroide product precipitates in the cells and the various wastes from the product concentration steps in Room D. These chemical wastes are discharged from the plant to underground tanks for storage, or, if possible, disposal.

Summary

All of the metal waste from the separations plant has been held in underground storage tanks W-3, W-4, W-9 and W-10. All of the chemical waste was held in W-5 and W-6 until March 6. At this time discharge of the supernatant from W-6 to the ponds was started and was continued until April 27. The rate of discharge did not exceed the rate of processing and the supernatant contained about .7% of the activity of the metal being processed. The discharge was diluted with about 100,000 cu.ft./day of cooling water which brought the activity in the mix to below the tolerance limit of 5×10^{-4} curies per cubic foot* However, a precipitate formed on dilution of the chemical wastes with the waste water which carried a large fraction of the activity. This active precipitate separates from the water, settling out in the bed of White Oak Creek, and creating an undesirable situation. Since April 27 the chemical wastes have been stored in tanks W-7 and W-8, which have sufficient capacity to last until about the middle of July. By this time it is expected that a settling basin will have been completed which will allow complete control of the active solids precipitated on dilution of the supernatant from the chemical waste so that discharge of the supernatant from the chemical waste tank can be resumed.

GENERAL DISCUSSION

Metal Wastes

The uranium containing waste after neutralization has a volume of 1670 gallons for each 1/3 ton batch of metal processed. Its approximate composition is: H_2O - 71.3%; $UO_2(NO_3)_2 \cdot 6H_2O$ - 8.7%; Na_2CO_3 - 5.2%; $NaHCO_3$ - 5.5%; $NaNO_3$ - .5%; Na_3PO_4 - 4.9%; Na_2SO_4 - 2.5%. The approximate quantities of the various radioactive fission products are given in Table 2. Sodium carbonate neutralization of the metal waste gives an essentially clear solution, since the uranyl nitrate forms a soluble complex with the excess carbonate. Figure A shows schematically the arrangement of the storage tanks for the metal wastes.

*Tolerance for 2 MEV gammas.

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FIGURE A

Metal Waste Storage Tanks

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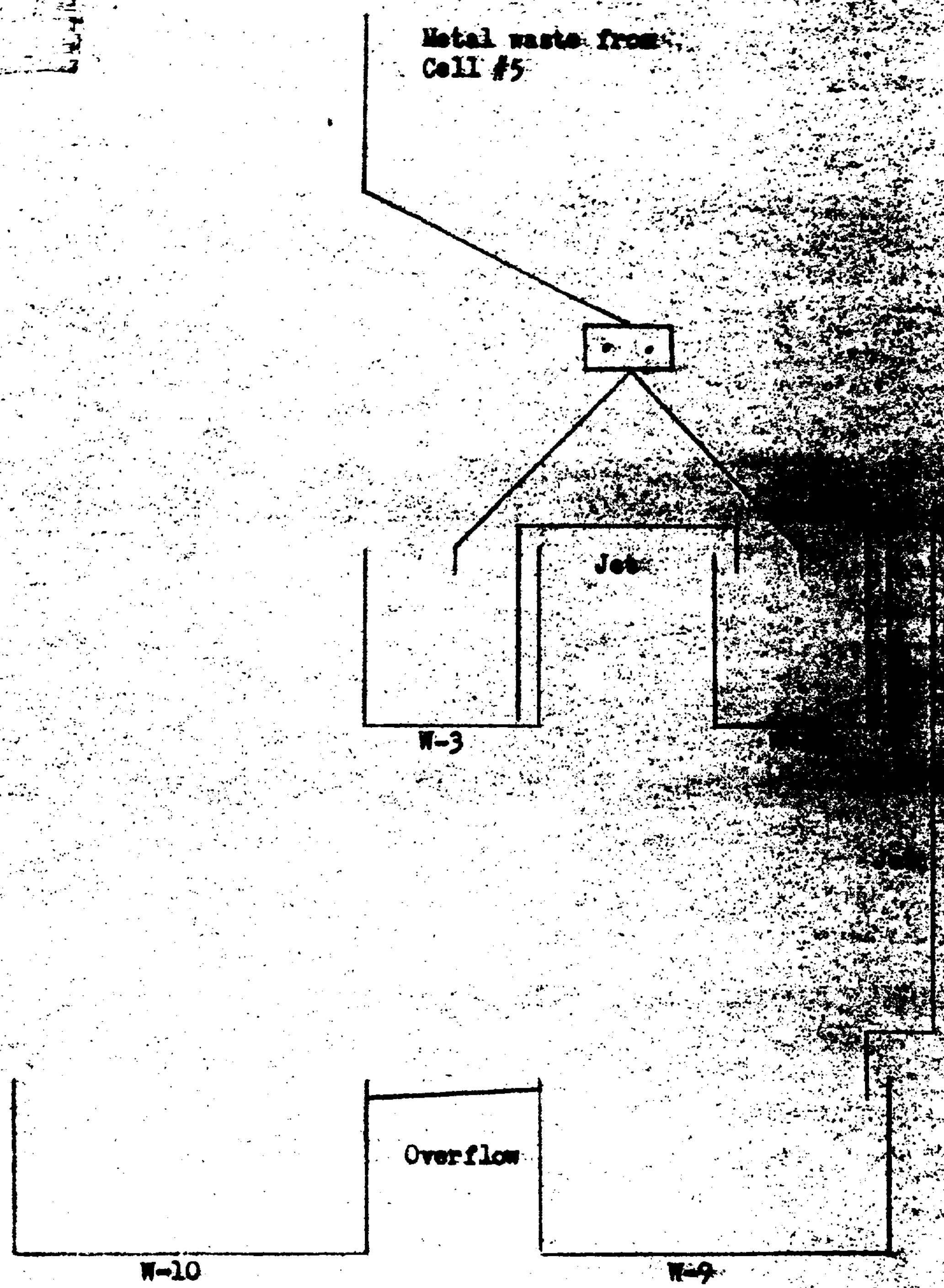

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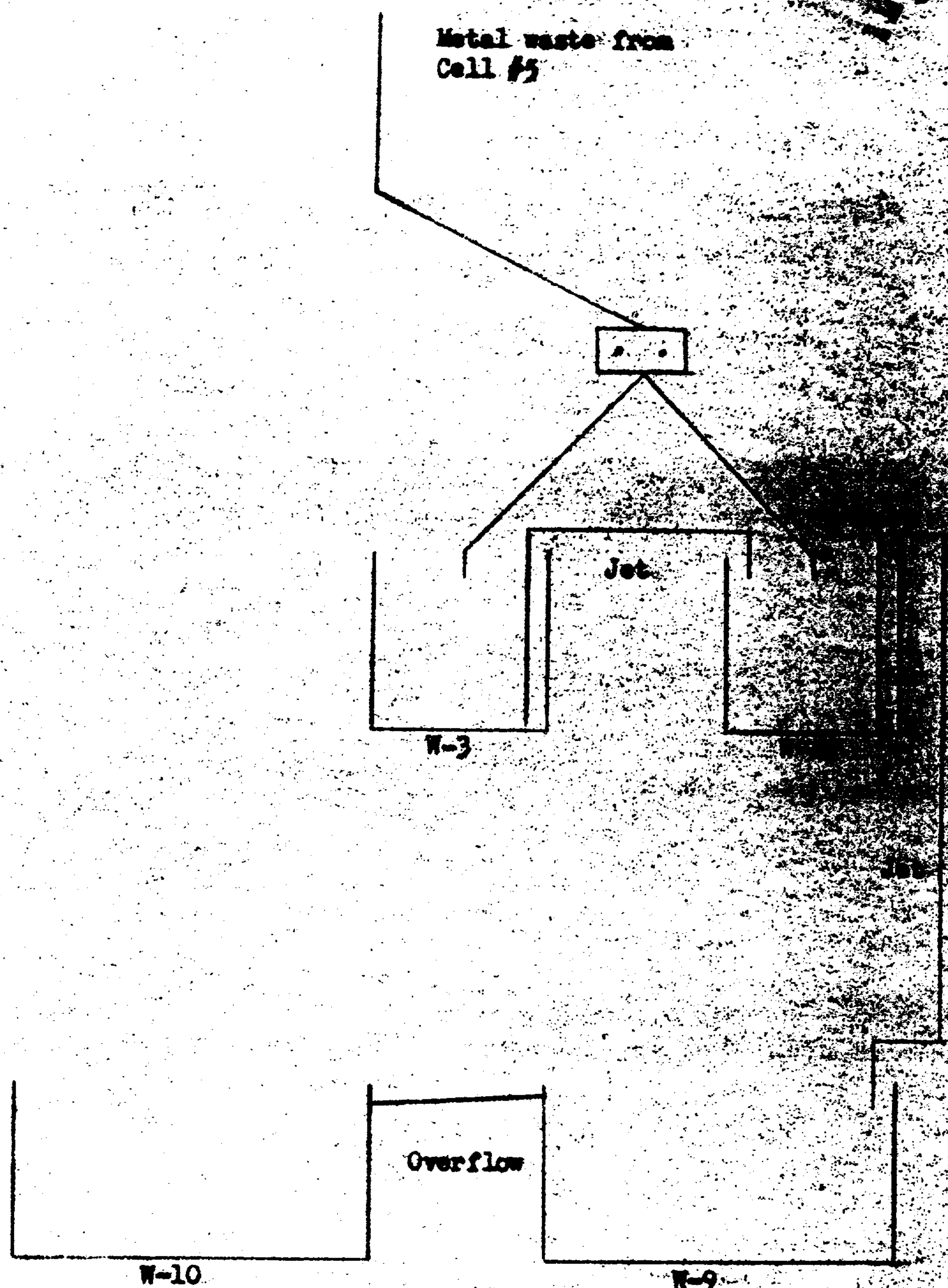
FIGURE A

Metal Waste Storage Tanks



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W-3 was filled first with the metal waste and then W-4. When W-4 was full, it was transferred to W-9 and then refilled. This operation was continued until April 22 when W-3 was also transferred to W-9 via W-4. These transfers and the accumulation in W-9 are shown graphically by Figure B.

Chemical Wastes

The approximate composition and volumes of the individual components which make up the chemical wastes are given in Table 1. The distribution of the radioactive fission products in each component is given in Table 2. About 93% of the activity in these wastes is carried by the precipitate formed when the solution is neutralized with sodium carbonate.

Figure C shows schematically the arrangement of the storage tanks for the chemical wastes. Beginning with the initial operation of the separations plant in December, 1943, and up to April 27, 1944, the chemical wastes were run to the storage tank W-5. This tank was filled and began overflowing to W-6 about February 14. On March 6 discharge of the clear supernatant from W-6 to the ponds was started. This was discontinued on April 27, except for a test run after this. Figure D shows the build-up of waste in W-5 and W-6 and the accumulated volume discharged from W-6 to the ponds.

The build-up of radioactivity in the chemical waste storage tanks, W-5 and W-6, and the total activity discharged to the ponds from W-6 is shown in Figure E. The total activity entering W-5 was calculated from the data in Table II, and that overflowing is estimated from the activity found in the supernatant. The difference is taken as the accumulated activity and since it has not been corrected for radioactive decay, it is high by the amount of decay which has occurred. On the basis of a tolerance limit of 5×10^{-4} curies per cubic foot of water, it should be possible to discharge 25,000 gallons of the supernatant material from W-6 to the ponds per day without exceeding this limit which is about five times the rate of accumulation of waste in the tanks. A discharge rate of 5,000 gallons per day seemed amply safe since further dilution would occur in White Oak Creek and in the Clinch River.

In practice the dilution of the chemical wastes with river water results in a precipitation of the minerals in the cooling water by the process chemicals, and this precipitate carries with it most of the activity from the wastes. This precipitate, which has a relatively high specific activity, collects in the still spots in the creek bed and can thus accumulate larger quantities than would be possible if this material did not separate. Analysis of the precipitate formed in the ponds gave the following results: Calcium as CaO - 3.8%; iron as Fe_2O_3 - 2.0%; aluminum as Al_2O_3 - 12.5%; silicon as SiO_2 - 67%; magnesium MgO - 2.1%; PO_4^{3-} - 4%; F^- - 26%. Analyses for radioactive elements are underway.

On April 25 after about 300 curies of activity had been discharged to the ponds, a survey of White Oak Creek showed that active material had washed down the creek and settled out on the bottom all the way to the dam just before the confluence of the creek with the Clinch River. Figure F shows the results of this survey in terms of microcuries per gram of dried mud. Also shown are microcuries per cc of water where this was obtained.

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FIGURE B

Accumulation of Metal Waste in W-3, W-4 and W-9

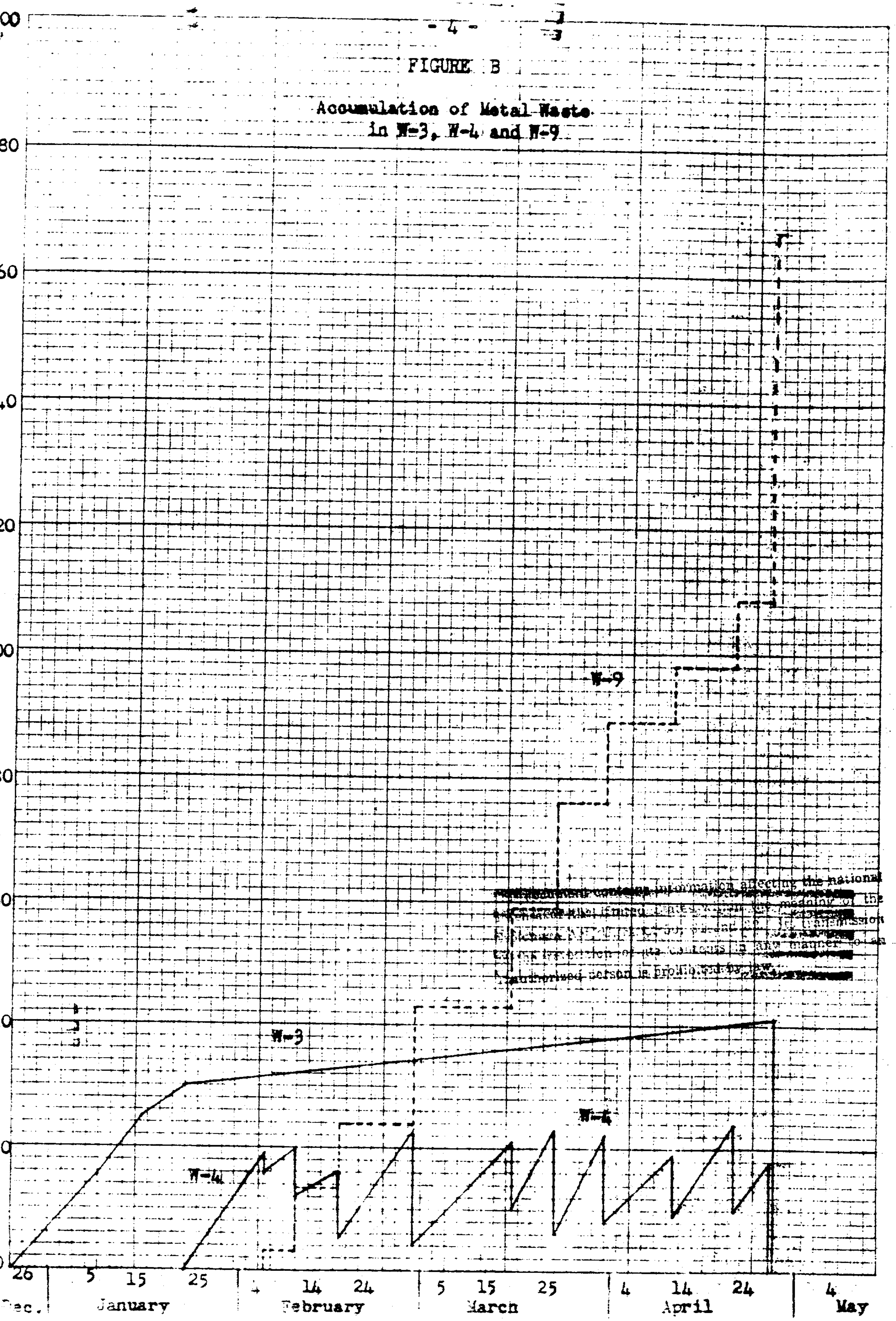

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Table I

Chemical Wastes - Compositions and Volumes

	Gals	% H_2O	% $Al(NO_3)_3$	% $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$	% $BiPO_4$	% Na_2CO_3	% $NaHCO_3$	% $NaNO_3$	% Na_3PO_4	% NaF	% KOH	% KF	% KNO_3	
Aluminum Coating Waste	203	86.6	3.4			6.6	1.1	1.7						
$BiPO_4$ By-Product Wastes	540	64.9			.7	1.9	5	22.8						
$BiPO_4$ Supernatant Wastes	1971	81.3		.5		2.3	5.7	3.9	4.8					
LaF_3 Supernatant Wastes	1802	85.3				.6	5.1	3.9	.8	2.5				
Composite Room D Wastes	508	94.3									1.2	.9	3.0	
Total Chemical Wastes	5016	83.7	.13	.22	.09	1.61	4.77	5.80	2.27	.90	.11	.09	.28	

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Table II

MILLICURIES OF FISSION PRODUCTS IN PLANT WASTES:*

Basis: One-third ton metal containing 1 gram product, made in 100 days and cooled 40 days.

ELEMENT	Zr	Cb	Ba	Sr	Pr	Y	La	Ce	I	Te	Cs	Totals
Total Millicuries	125,000	110,000	50,000	180,000	130,000	200,000	60,000	130,000	6,250	5,700	2,000	999,000
Millicuries in Metal Coating Waste	250	220	100	360	260	400	120	260	12	11	4	2,000
Millicuries in Extracted Metal Waste	89,000	98,000	49,000	178,000	95,000	196,000	58,500	114,000	6,250	5,400	1,980	891,000
Millicuries in First By-Product Bismuth Waste	35,000	11,000	270	2,050	13,000	600	-1,500	15,000	0	0	--	75,000
Millicuries in Decontamination Waste Centrifugate	62	190	530	20	21,000	3,200	4,000	580	6.5	280	20	30,000
Millicuries in Second By-Product Bismuth Waste	44	480	.6	.02	270	6	6	42	.28	4.6	--	850
Millicuries in Fluoride Waste Centrifugate	.2	9	.3	.02	380	10	68	2	--	.5	.2	470
Millicuries in Room D Wastes	.8	.9	3	.08	310	24	10	.1	--	--	--	350
Total Millicuries to W-5 and 6	35,000	12,000	900	2,400	34,000	4,200	3,000	16,000	19	296	24	108,000

*Calculated from data in CN-1309, CC-829 and data from D. N. Hume.

Supernat. from W-5, 6 2000 180 7 35 Ru 75 18 800 180 110 3750
Mud in Ponds 2000 140 35 650 3500
Seepage from 45 45 110 45 350

FIGURE C

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Chemical Waste Storage Tanks

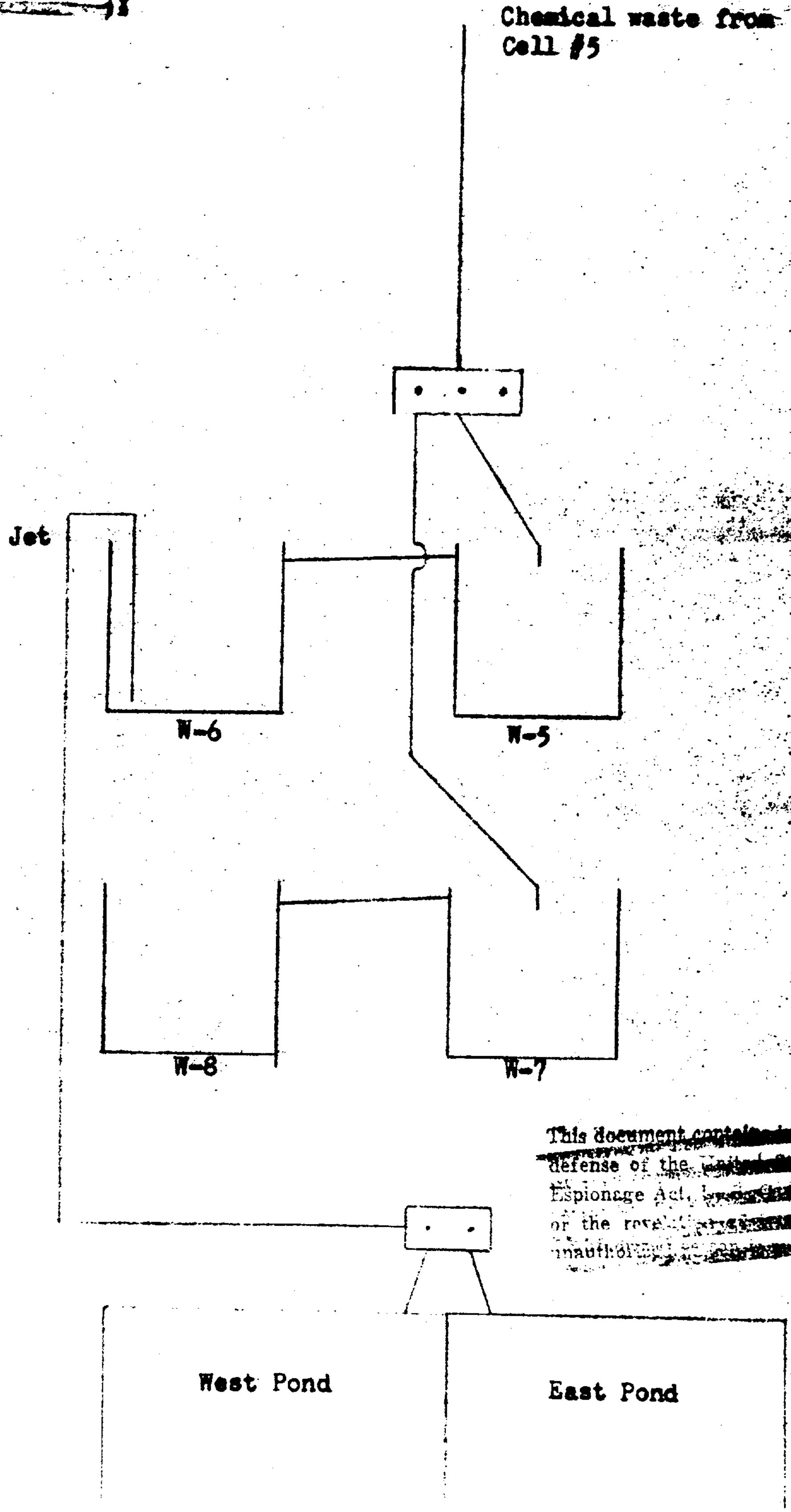

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FIGURE D

Accumulation of Chemical Wastes in W-5, and W-6, and Discharge to Ponds

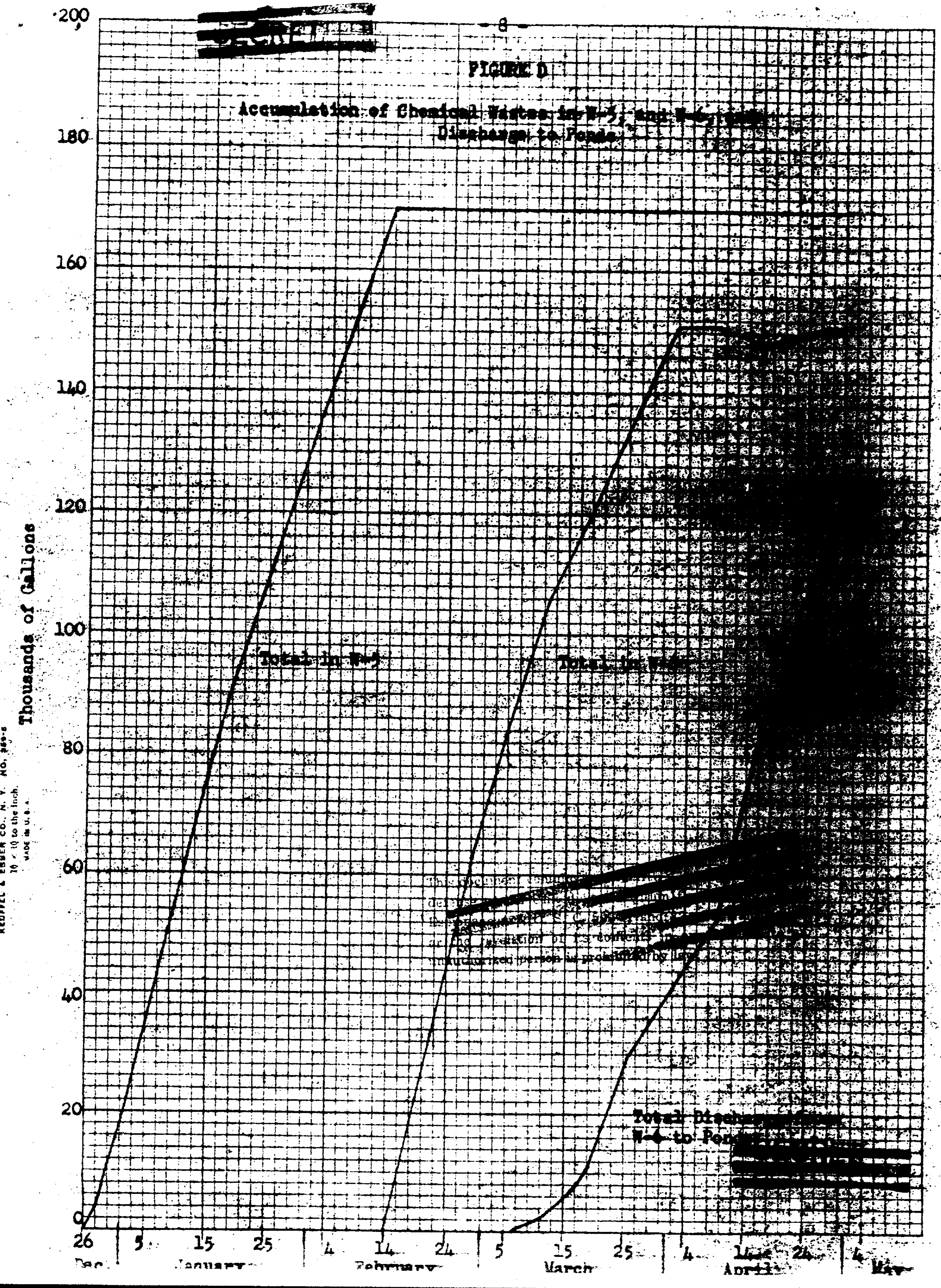

FIGURE 5

Accumulation of Activity in M-5 and M-6
and Discharge of Activity to Ponds

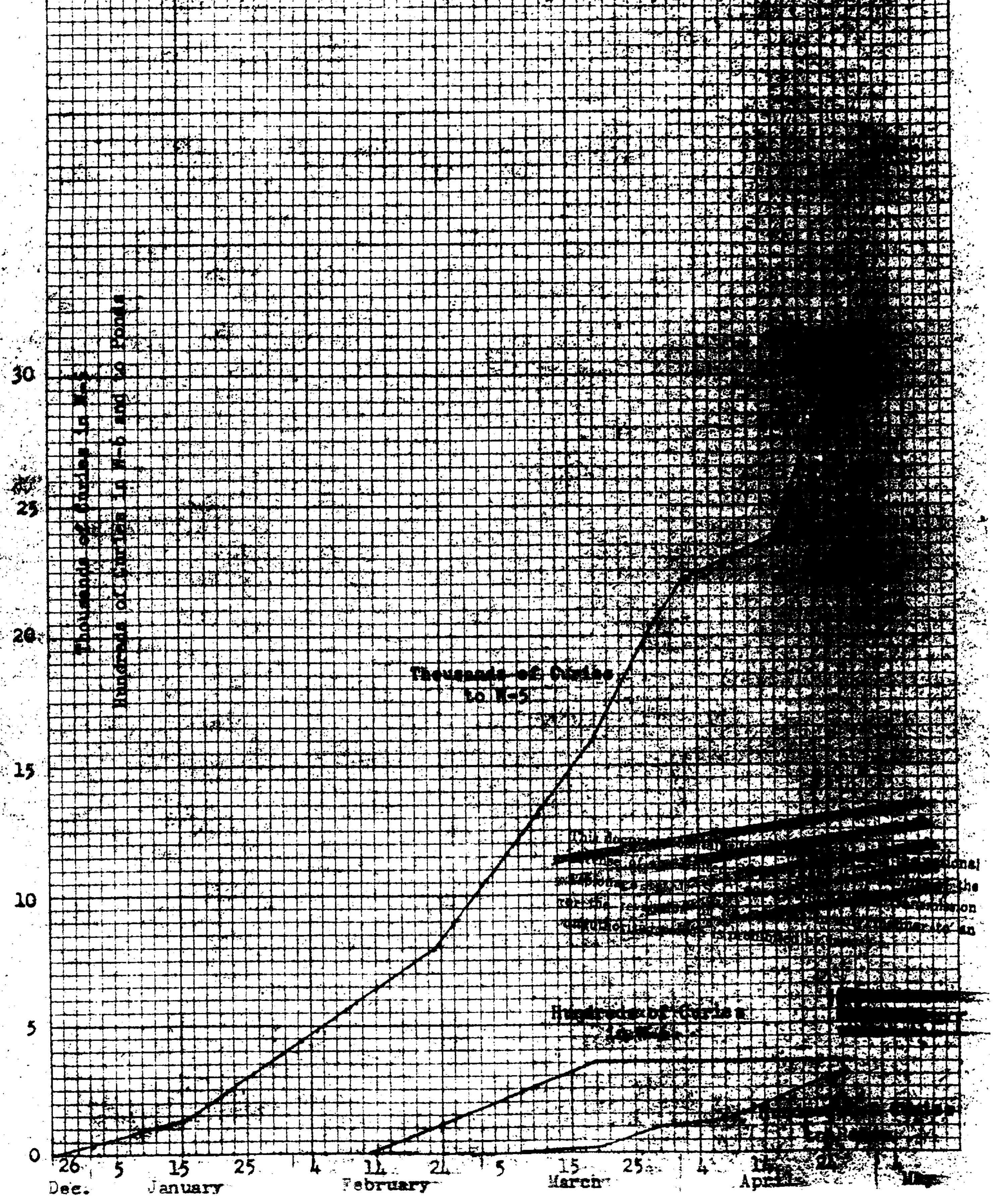

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Figure 1

Survey of White Oak Creek

M = microcuries/gram dry mud
W = microcuries/cc water

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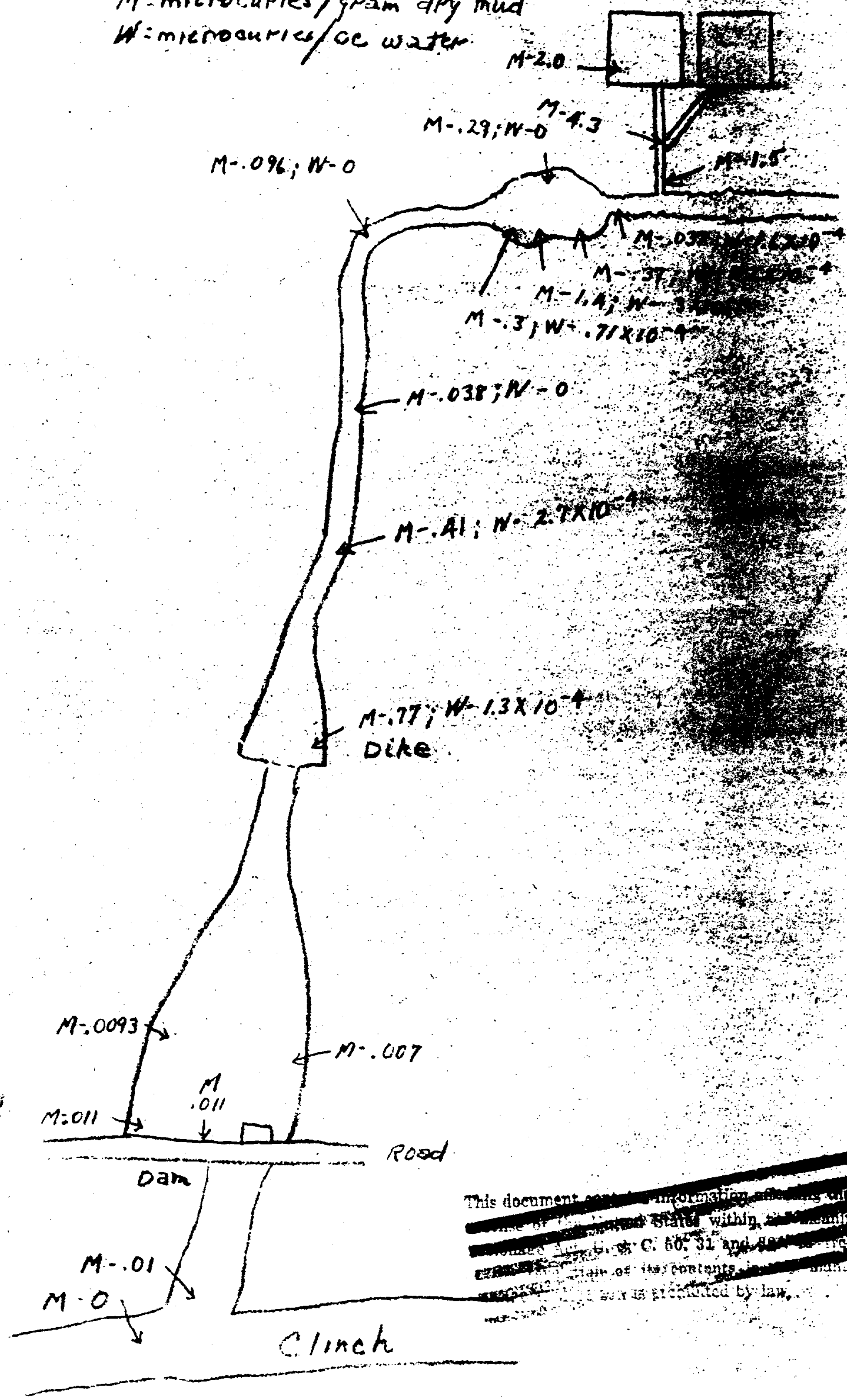

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The water in each pond is analyzed for beta counts/5 cc before discharge of the ponds to White Oak Creek. During the period of discharge of chemical wastes from W-6 to the ponds, these readings were considerably higher than before or after the discharge was begun. To illustrate this point, the total readings on any one day are added and plotted against the day in Figure G. The higher daily totals of readings (in the range of 1,000) always represent three or more ponds discharged per day.

The water flowing in White Oak Creek was collected behind the dam near the mouth of the creek (see Figure F) and monitored before being discharged to the Clinch River. The maximum reading obtained on this water at any time was less than 0.1 milliroentgen per hour.

The discovery that the sludge precipitated in the ponds contained a large fraction of the activity, suggested that it would be possible to treat the chemical wastes in W-5 and W-6 and decontaminate them effectively. Laboratory tests indicated that it might be possible to decrease the activity in the supernatant from W-5 and W-6 by a factor of ten by adding calcium chloride to W-5 and allowing the precipitate to settle in W-6. (Ferric sulfate addition was also tried, but it was not as effective as calcium chloride nor did it improve the results obtained with calcium chloride alone when it was combined with the calcium chloride.) The effectiveness of the calcium chloride when added in the laboratory to a sample of the plant waste is illustrated in Table III.

Table III

Laboratory Decontamination of Plant Chemical Wastes with $CaCO_3$

A: .04% $CaCl_2$ added once only (equivalent to 500 lbs. $CaCl_2$ in W-5)

B: .04% $CaCl_2$ added each day.

Continuous air agitation of liquid phase in both.

Days of Treatment	1	2	3	5	6	7	8	9
		Percent of Original Activity						
Sample A	43	44	39	40	39	40	40	40
Sample B	49	28	18	13	12	10	9	8

Treatment of the plant waste in W-5 with 500 lbs/day of calcium chloride was begun on April 17 and continued 10 days. The results are summarized in Table IV*. After five days of treatment the activity in W-5 had decreased to 38% of the original. The downward trend was reversed after this, probably due to the increase in level of activity of the waste entering the tank. The addition of calcium chloride was discontinued after April 27 when the plant discharge of waste was cut from W-5 to W-7, a new tank, where all of the wastes will be stored until provision can be made for decontaminating the wastes sufficiently to allow disposal to the creek.

*See Table IV on following page.

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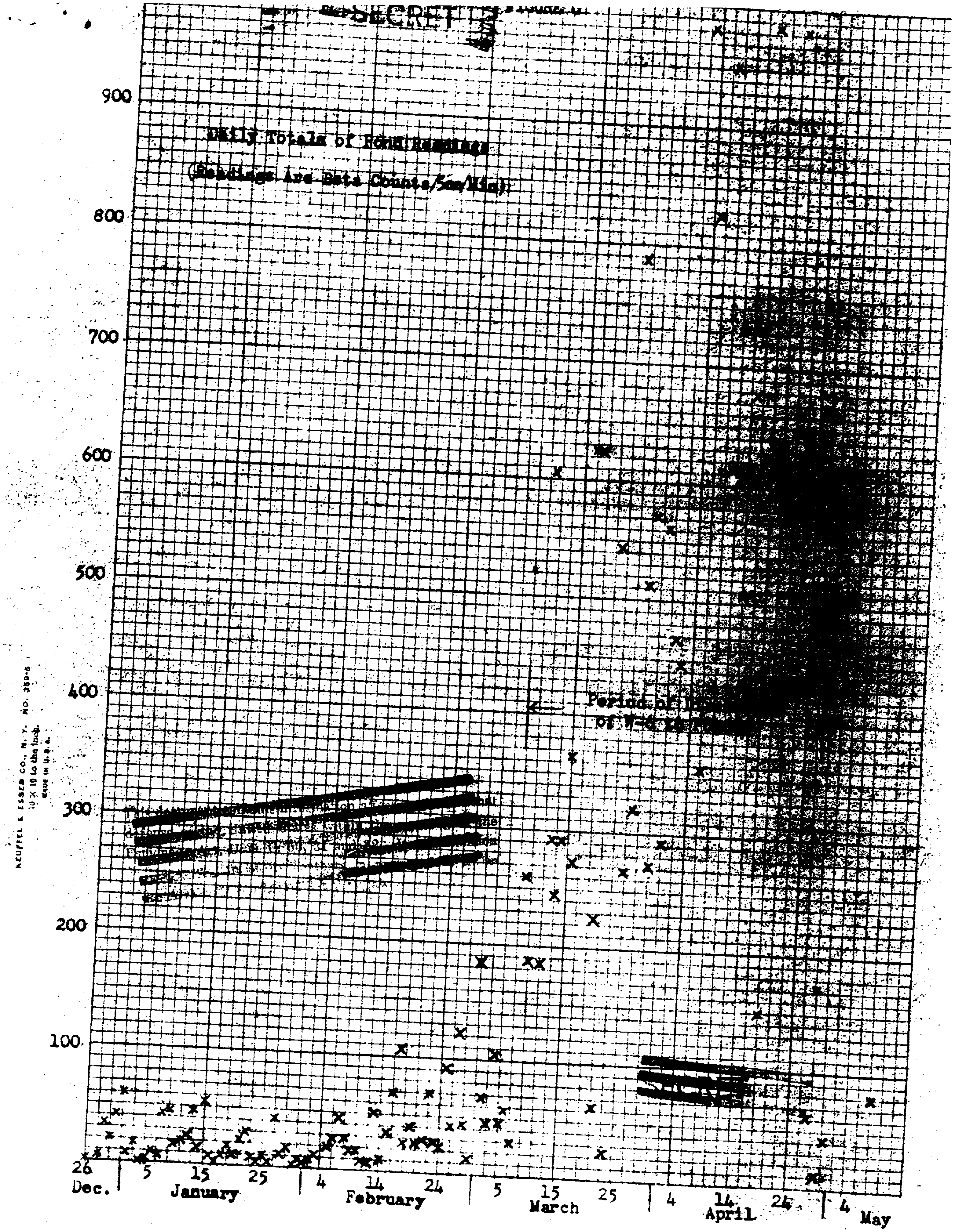

Daily Totals of Hand Readings
(Readings Are Beta Counts/5cm/Min)
900
800
700
600
500
400
300
200
100
Period of
[redacted]
[redacted]
26
Dec.
5
15
January
25
4
14
February
24
5
15
March
25
4
14
April
24
4
May
KEUFFEL & ESSER CO., N. Y. NO. 359-5
10 X 10 to the Inch.
MADE IN U.S.A.

[redacted]

Table IV

Plant Decontamination of Chemical Wastes with $CaCO_3$

Date Sampled	Number of 500# Batches of $CaCl_2$ Previously Added to W-5	% of Original Activity in W-5	W-6	Gamma Counts/cc in Plant Metal Solution Being Processed
4/17/44	0	100	100	.57
4/18/44	1	72	99	1.1
4/19/44	2	68	98	.76
4/20/44	3	58	93	.92
4/21/44	4	45	91	1.5
4/22/44	5	38	82	1.6
4/23/44	6	--	--	1.3
4/24/44	7	46	82	2.4
4/25/44	8	45	73	2.3
4/26/44	9	54	74	--
4/27/44	9	54	78	--

The waste from W-6 was diluted in the laboratory to various extents with pond water to determine on this scale the amount of decontamination obtained. The activity was decreased in proportion to the amount of dilution as shown in the following table:

Table V

Decontamination of Plant Waste on Dilution with Pond Water

Dilution Ratio	70-1	35-1	14-1	7-1	2.8-1	1-1
% of Original Activity Left in Solution	11.8	12.4	15.9	29.2	76	87.8

The precipitate formed in these tests was proportional to the amount of dilution water used and amounted to about 2 to 3% of the dilution water volume. The solids settled to this volume in about an hour (in 1' of liquid depth).

On April 30 and May 1, an experimental run was made with the ponds to determine their effectiveness as settling basins for the precipitate formed on dilution of the waste with the pond water. An overflow was provided for the east pond, and it was used as a continuous settling basin. A parallel test was run on the west pond using it as a batch settling basin. The beta counts/cc/min obtained on the overflow and the supernatant from a centrifuged sample of the overflow are plotted in Figure H. Similar samples were taken from the surface of the water in the west pond (batch test) and are shown in Figure I.

From these data it appears that a lower limit of 15-20 beta counts/min/cc (corresponds to about 700 millicuries per day) can be obtained if the solids are effectively

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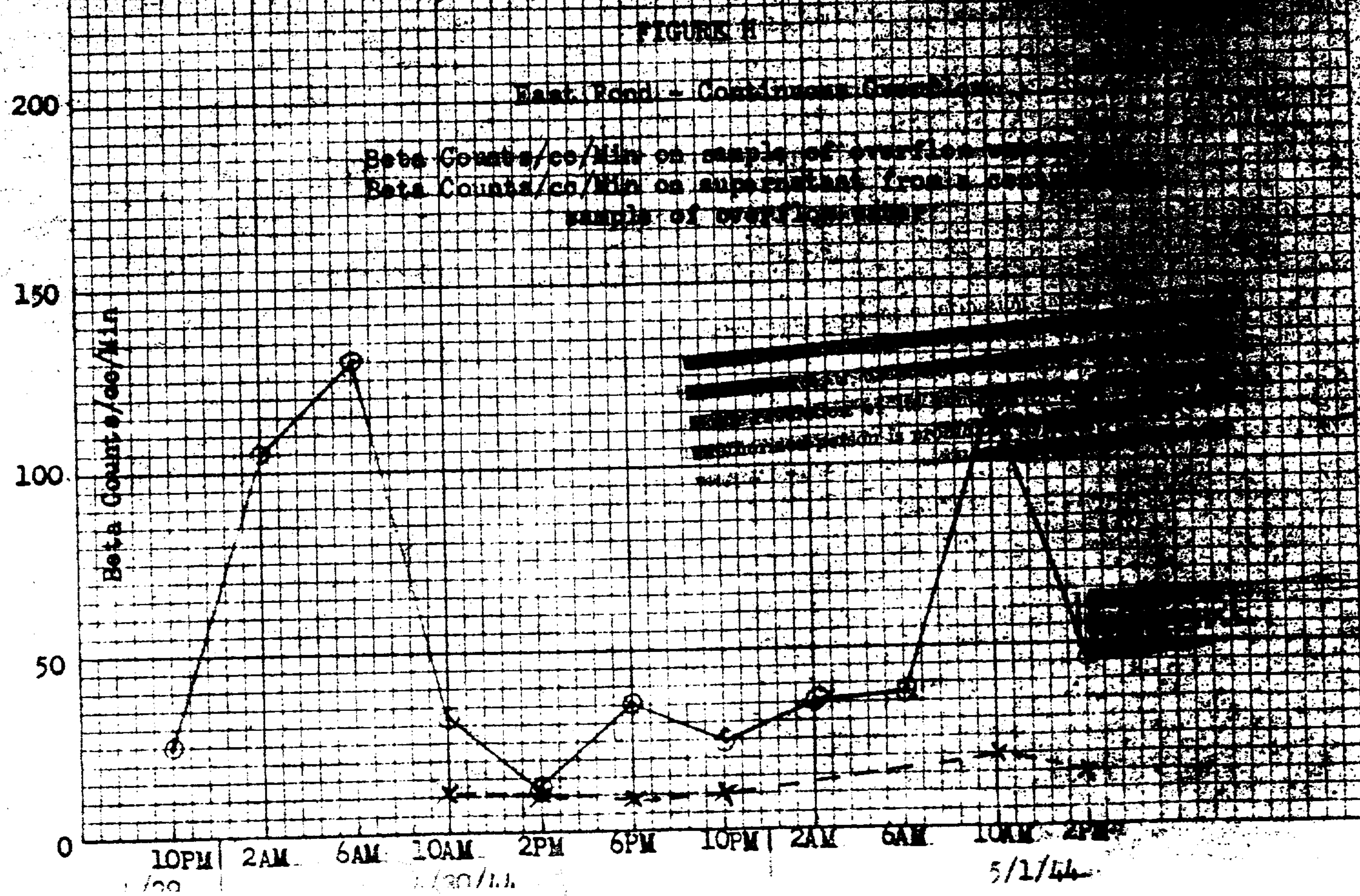

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settled out. This limit was approached at times during these tests, but the tests were not of sufficient duration to find what percentage of the time this could be done.

It is proposed to build an additional pond between the present ponds and White Oak Creek to be used as a settling basin in order to effectively remove all precipitated solids. The hold-up in this pond will be about 30 hours. An experimental program is underway to confirm this and the other bases for the design of the new pond. Since the remaining storage tanks can handle the chemical wastes for only two more months, design and construction of this settling basin will proceed without waiting for completion of all of these confirmatory experiments. It seems reasonably certain that the total activity leaving such a pond would not exceed one curie per day when handling wastes having the level of activity of the present materials. It is quite possible that the discharge can be held to a much lower volume than this by the introduction of additional adsorption agents.

W. Q. Smith

W. Q. Smith

WQS:dp

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